**Stereo images data compression and digital stereo compatible TV**

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## ABSTRACT

In contrary to the Grand Alliance's HDTV Standard, which is **incompatible** with the existing TV standards, author submits the digital stereo compatible TV standard (NTSC-DSC) which is **completely compatible** with the existing TV standards and advances **a new image quality** of TV - its 3D stereo visualization making the stereo TV like real Tele Vision when remote viewers can see from new stereo TV sets pictures in the same manner as they can see these pictures directly by their two eyes without TV. The main issues of the compatible stereo TV are multiplexing of the coupled stereo TV signals into one TV stereo signal compatible with the existing TV standard NTSC (PAL, SECAM), and digital video data compression as the tool to achieve such multiplexing. This paper is concentrated on the specific description of the method and technique of the digital video data compression of the one stereo ("left") TV signal and then time-division multiplexing of such highly compressed digital "left" TV signal-file inside the other original analog NTSC "right" TV signal. The essential stereo visual redundancy of the coupled TV signals reflects the fact that these stereo TV signals looks like mainly the same, like "twins". If the stereo base of stereo binocular TV camera is along the TV line scanning, then there is a lot of identical, corresponding runs of pixels in both "left" and "right" TV signals for any TV scanning line. Such identical twins-runs are set apart by the shift along TV line depending on the distance to according image objects from TV camera. The possibility of the time-division multiplexing based on the information emptiness for time intervals of the standard TV signal occupied by flaybacks of TV scanning.


KEYWORDS: TV, digital TV, video data compression, stereovision, 3D visualization.

## 2. INTRODUCTION.

The history of TV standards is to some extent the history of the technological innovations of the XX century. It starts from the black-and-white (grayscale) TV broadcasting earlier in Britain in 1936 and then after in the USA in 1939 as the result of the first technological revolution deeply associated with the mature level of the vacuum-electronic devices - the predecessors of the solid state, semiconductor devices. The next step of this TV history is the color TV broadcasting starting by the NTSC standard in the USA in 1953 and then after in Europe by PAL and SECAM standards in 1966 as the result of the technological innovations deeply associated with the technological progress inspired by the necessities of the World War II.

Now, on the verge of the next century, after 40 years of the constantly evolution of the TV quality improvements in the frames of color TV standards like NTSC, PAL, and SECAM the world is on the crossroad to design and accept the next TV standard which is available and affordable as the result of the semiconductor-digital-information technological revolution taking place in the second half of this century.

In spite the long history of the R&D on the way to this future TV standard, huge of money involved for such R&D, the failures of the Japan and Europe in previous attempts to design and submit the new TV standard for USA [1], and the design and submission to FCC by the Grand Alliance the new digital HDTV standard [2] **incompatible** with existing NTSC standard, it's still not clear enough what will be the real future major innovation in TV, will be this innovation welcomed by TV producers and bought by customers-TV viewers, if so what will be the next TV standard.

Let's note here that all existing TV standards are still provide only the **2D reflection (approximation)** of the 3D reality which human beings are able to see directly without TV by his/her **two** eyes **stereovision**. Really, all existing standard technologies of video (image) data acquisition, transmission, recording, and visualization of TV and digital computer imagery data provide nonstereo (mono) vision rather for mythological cyclopes than for normal two eyes real human beings. Nevertheless, we human beings accepted such truncated 2D visual reality in the same manner as we accepted before grayscale pictures instead color pictures not because we love much more such truncated 2D visualization but rather because there are available and affordable technologies in our arsenals which provide only the 2D (mono) TV representation of the 3D (stereo) reality.

Let's go back in time and imagine what colossal step was the transition from grayscale to color visualization, the transition from one component (luminosity) to three components (luminosity, hue, and saturation) color visualization!

It seems to author that the next step in TV standards needs to be such future TV standard which provides the transition from the color 2D TV to the color **3D stereo** TV rather than some spatial resolution increasing for the color 2D(mono) TV visualization promising by the Grand Alliance digital HDTV standard.

Learning the lessons of the previous transition from grayscale TV standard to color TV standard - the failure of the CBS's **incompatible** standard and the success of the NTSC **compatible** standard, it needs to be recognized that the chance to succeed in the market place has only such future TV standard which is **completely compatible** with the existing NTSC standard.

But is it possible by the principle to create such compatible stereo TV standard? The goal of this paper is to answer directly and in the constructive manner ***yes*** and to describe the general principles, algorithms and tools to achieve such complete compatibility for the future digital stereo compatible NTSC - NTSC-

DSC.

## 3. THE GENERAL PRINCIPLES OF THE DIGITAL STEREO COMPATIBLE TV - NTSC-DSC.

As it was mentioned, a new image quality provided by the DSC TV is the 3D visualization, the stereo TV. It means that on the transmitter side the stereo binocular TV camera has to have two image sensors, scanned under NTSC (PAL, SECAM) standard synchronously, with a stereo base along the direction of line scanning. Such two image sensors stereo binocular TV camera generates a couple of TV signals - the "left" and "right" TV stereo signals of the same scene viewed **slightly different** by these two stereo image sensors.

Before description of the methods and tools to achieve the compatibility for the NTSC-DSC TV let's remind that the compatibility for the color NTSC with grayscale TV exploits some features of human color vision, which certify narrower bandwidth needed for the chrominance components, and the unoccupied frequencies concentrated between the harmonics of the line frequency by frequency-division multiplexing of the chrominance narrow bandwidth components $(I, Q)$ inside the main bandwidth of the luminance component $(Y)$.

It means, particularly, that there is not any additional possibility for the frequency-division multiplexing in the NTSC signal. Therefore, the compatibility for the NTSC-DSC TV signal may be achieved only if it will be found some other than bandwidth (frequencies) emptiness and frequency-division multiplexing capabilities for the NTSC signal.

Fortunately, such time emptiness, unoccupied by information time intervals are remained in the NTSC signal - they are the time intervals according to the horizontal and vertical flybacks of TV scanning. Such unoccupied time intervals according to the NTSC standard reside only small part of the TV frame duration. Therefore, time-division multiplexing of the "left" stereo TV signal inside the "right" stereo TV signal will be available only if it is possible to **compress** preliminary the "left" stereo TV signal till such degree that such compressed "left" TV signal (digital file) may be fit to the empty from information time intervals of the horizontal and vertical flaybacks of the main ("right") NTSC TV signal.

Such potential capability for highly video data compression of the stereo ("left") TV signal exists because there is very essential **statistical stereo redundancy** of the stereo couple of TV signals.

Therefore, first of all let's accentuate such specifics of the stereo redundancy of the couple of the stereo TV signals.

Such specifics of the stereo redundancy of the couple of the stereo TV signals starts from the method used to generate the couple of the stereo TV signals by the stereo binocular TV camera.

The stereo binocular TV camera has to have two image sensors with a stereo base shift $\boldsymbol{\Delta d}$ between two image sensors along the direction of the line scanning (the value $\Delta d$ is usually the same as the distance between our two eyes but can be increased as it is done for the binocular field glasses to increase the distance of the stereo vision) which are scanned under NTSC (PAL, SECAM) standard synchronously. Such two image sensors stereo binocular TV camera generates a couple of the stereo TV image signals - the "left" and "right" TV stereo signals of the same scene viewed slightly different by these two stereo image sensors.

The potential capability for the highly video data compression of the one from the couple of the stereo TV signals - let's it to be the "left" TV signal adding the 3D stereo effect to the basic ("mono") "right" TV signal - exists because there is very essential stereo statistical redundancy of the couple of the stereo TV signals. Really, both the "left" and "right" stereo TV signals have much in common, they looks like the same, to some extent, they are only slightly different because they represent the same real scene viewed by two image sensors shifted on stereo base along the line scanning direction.

As it's well known, the shift $\Delta x$ between line coordinates for the "left" and "right" **corresponding** pixels responsible for the **same** point of an object of the real scene will be determined by the distance ($z$ coordinate) of this point to the stereo base line of the stereo TV camera, the focal distance of the TV camera objectives $f$, and the stereo base shift $\Delta d$ as

$$\Delta x = \frac{\Delta d \times f}{z}$$

Therefore, the "left" stereo TV signal for the majority of its pixels of any scanning line will have the same, corresponding pixel on the same scanning line of the "right" stereo TV signal, and a line position of such corresponding pixel is shifted relatively to the line position of the according pixel in the "left" stereo TV signal of the same line on the value proportional to $\Delta x$. Meantime, for the rest minority of the pixels, particularly pixels belonging to the beginning and the end of the scanning line, of the "left" stereo TV signal it will be impossible to find the corresponding pixels in the "right" stereo TV signal.

Such specific stereo statistical redundancy of the stereo TV signals allows to design the special video data compression technology for the video data compression of the one, "left" stereo TV signal in the presence of the stereo uncompressed other, "right" stereo TV signal. In other words, the stereo video data compression of the "left" stereo image (TV frame) needs to reduce the data of the original "left" stereo image to the minority of the pixels of the "left" stereo image having no correspondent pixels in the "right" stereo image, and for the majority of the rest pixels of the "left" stereo image having corresponding pixels in the "right" stereo image to the data of the line scanning shifts of these corresponding pixels of the "right" stereo image. It means that the core procedure of the stereo video data compression technology needs to be the procedure of the search and selection of the corresponding stereo pixels between the "left" and the "right" stereo images.

Such compression technology starts from the **digitizing** both stereo TV signals because any kind of video data compression of TV signal is available **only** for its **digital** form.

The digitizing of the TV signal, the transition from analog TV signal to the TV digital data file **clusters** the neighboring pixels on any scanning line in some **runs** of pixels. Let's name for the digital TV image data file the group of the neighboring pixels of the scanning line having the same discrete level from the alphabet **m** of the analog-to-digital conversion (ADC) of the analog TV signal as the **run**, and the group of the neighboring runs as a **fraction**. The length of the run may be from ***1*** pixel till ***N*** pixels where ***N*** is the number of pixels on TV line. The length of the fraction may be also measured from ***1*** till ***N*** pixels, or may be measured by the number of runs constitutes this fraction from ***1*** run till ***N*** runs. Such clustering of the image pixels in their **digital** image file on the runs and fractions of the pixels is the reflection of the spatial redundancy typical for any purposeful image.

The appearance of the runs in the digital image data file authorizes the search and selection of the corresponding runs of the pixels in two digital stereo image files instead of the search and selection of the corresponding pixels. It's well understandable that the search of corresponding runs is essentially speedy and it's simpler to optimize than the search of the individual corresponding pixels.

Therefore, let's analyze the digital "left" and "right" TV signals-files for the same TV scanning line by the search and selection of the **identical** runs and fractions as the **corresponding** runs and fractions in both digital TV signals-files. With this goal let's start from the first (in the scanning order) run of the digital "left" TV signal-file and try to find identical run (by the length and discrete level) in the digital "right" TV signal-file which can be shifted along the scanning line relatively to the position of the corresponding run in the digital "left" TV signal-file. There is possible to find some identical runs, different in their position, shifts. Therefore, let's select among all possible identical runs as the matched identical corresponding run the run having the smallest shift.

There are two possible results of such search of the matched identical run - this matched identical run exists or doesn't exist. In the last case the first run of the digital "left" TV signal-file is rewritten on the same position in the first additional frame (image) memory forming some artificial "left" TV digital image possessing only noncorresponding pixels (runs, fractions). In the case when the matched identical run is found and located such found corresponding run from the "right" digital stereo image file is rewritten in the second additional frame (image) memory in the same position but instead the discrete level of the luminosity from the alphabet **m** for the pixels of this corresponding run there are rewritten the discrete level of the **stereo shift** from the alphabet of possible shifts ***fn*** (in pixels).

In the same manner it will be processed all next runs of the "left" digital stereo image data file and for all scanning lines of this image (TV frame). At the end of this procedure there are written in two additional frame (image) memories the artificial "left" digital image in the first additional image memory and the artificial "right" digital image in the second additional image memory.

The artificial "left" digital image has all pixels belonging to the unmatched noncorresponding runs of the original "left" stereo digital image on the same position as they are in the original "left" digital image, and for the rest majority of the pixels belonging to the runs having the matched corresponding runs in the "right" stereo digital image there are written the uniform additional flag discrete (***m+1***)th level instead their discrete levels of luminosity from the alphabet ***m.***

The artificial "right" digital image is formed by another way - there are written the discrete levels of the according stereo shifts from the alphabet ***tn*** instead their discrete levels of luminosity from the alphabet ***m*** for the majority of the pixels belonging to the matched corresponding runs, and for the rest minority of the pixels belonging to the runs having no corresponding runs from the "left" digital image there are written the uniform flag discrete (***n+1***)th level instead their discrete levels of luminosity.

Both such artificial "left" and "right" digital images created by the above-mentioned procedures have extremely high **spatial** redundancy reflected by their extremely **nonuniform** probability distribution of the discrete levels of their pixels, and, therefore, may and have to be highly compressed by the appropriate standard image data compression technology for the still imagery data.

So, the original "left" stereo image will be highly compressed and represented by the two compressed artificial "left" and "right" digital image data files which will be then time-division multiplexed with NTSC "right" TV signal by the inserting these two compressed artificial "left" and "right" digital image data files into the time intervals according to the horizontal and vertical flybacks of TV scanning emptied from information. Such time-division multiplexed NTSC "right" TV signal is the NTSC-DSC TV signal.

On the receiver side this NTSC-DSC TV signal needs to be converted to the couple of the original "right" and "left" stereo TV signals.

Therefore, the NTSC-DSC TV signal, first of all, need to be demultiplexed on the original NTSC analog "right" TV signal and two compressed artificial atrificial "left" and "right" digital image data files. Demultiplexed original NTSC analog "right" TV signal after ADC forms the digital file of the original NTSC "right" TV signal which is written in the frame memory of the digital "right" TV signal.

Decompressed image data file of the artificial digital "left" image is written directly in the frame memory of the forming the digital "left" image by filling all pixels of the original "left" stereo image having no corresponding pixels in the original "right" stereo image. Decompressed image data file of the artificial digital "right" image is written in the buffer frame memory. Then the buffer memory of the artificial "right" image and the frame memory with the original "right" TV signal(image) are read (scanned) synchronously. For all pixels of the "right" image having corresponding pixel in the "left" image its value from the "right" image memory rewritten under the control of the reading the value of the shift for this pixel from the buffer memory to the corresponding pixel of the frame memory of the "left" digital image filling in such manner all pixels of the "left" stereo image having corresponding pixels in the "right" stereo image. Therefore finally, it will be finished the recreation of the "left" digital stereo image in this image memory.

By the DAC of the "left" digital stereo image (TV) file and the "right" digital stereo image (TV) file there will be recreated both original analog "left" and "right" stereo TV signals providing the possibility for their stereo visualization and perception.

There are some remarks need to be added.

First of all, the strong stereo correlation between the corresponding pixels in the "left" and "right" stereo images exists only in **one** dimension - in the line (***x***) scanning direction, and the search and selection of the identical matched corresponding runs is carried out for the runs on the **identical scanning lines** for both original "left" and "right" digital image files. Therefore, all above-mentioned procedures may be implemented using the line memories instead the frame memories for the generation of the two artificial "left" and "right" digital image files and their image data compression.

Secondly, the search and selection of the matched identical corresponding runs in the "right" stereo digital file for the runs of the "left" digital file is carried out only for the luminosity component of the color image signal whereas the selection of the corresponding runs for the two other chrominance components is ruled out by having been searched and selected corresponding runs of the luminosity component.

Let's note also that the described technique of the stereo video data compression/decompression is asymmetrical technique when the decompression and reconstruction of the data of the original "left" stereo signal is essentially simpler than the technique of the data compression of the original stereo "left" signal.

Among all other digital image data procedures for such data compression of the "left" stereo signal the procedure which consumes the most computer processing power, memory, and time is the search and selection of the matched identical corresponding runs between both the "left" and "right" stereo images files. Therefore, the optimal choice of the appropriate search procedure providing the speediest search is very important.

The above-mentioned search procedure of the runs in the scanning order is not the speediest one in the general case. The most likelihood scenario to optimize the search procedure is to start the search from the run having the maximal length and if the search result for such run is positive then to continue the search for the runs neighboring to this run having the maximal length until it will be located the run from these neighboring runs which has not matched identical corresponding run. As only such unmatched run will be located the search will be started again from the runs that have not been examined yet for the run having the maximal length.

Let's note that the strategy to make the search among the neighboring runs is grounded on the suggestion that some of the neighboring corresponding runs will constitute likely the fragment belonging to some image object located at some settled distance from the stereo image sensors.

Let's remark here also that for the NTSC-DCS TV stereo signal the essential additional compression and simplification of the compression/decompression hardware and software may be achieved by the additional reduction of the psychophysiological redundancy of the human stereo vision. It's well known, that the resulting visual sharpness of the human stereo vision perception is determined by the sharpest stereo image from the couple of stereo images ("left" or "right" - the main mono image component), and the stereo effect of human stereo vision perception is supported by adding to main mono image component another stereo image component even in the case when such additional stereo image component is less sharper than the main mono image component. For NTSC-DCS stereo TV it means that among the couple of the TV stereo signals (images) the "left" stereo image may be less sharper (with the smaller spatial resolution power) than the main "right" image, and, therefore, the search and selections of the matched identical corresponding runs may be fulfilled by analysis both "left" and "right" digital video files having smaller spatial resolution power than the original analog main mono "right" TV signal has. Such situation is quite similar to the psychophysiological feature of human color vision when the chrominance components don't need to have the same high spatial resolution as the luminosity component has to have. It's the reason why the chrominance components of the NTSC TV signal have the smaller spatial resolution and bandwidth accordingly than the luminosity component has.

Let's emphasize that the **complete compatibility** of such new NTSC-DSC stereo TV standard with the existing NTSC TV standard means that:

- not only all possessors of the existing nonstereo TV sets will be able to see the stereo TV programs in their mono version but all possessors of the new stereo TV sets will be able to see the nonstereo broadcasting TV programs and having been broadcasted before with the help of the standard VCR;
- the main equipment of the existing TV transmission stations, telecommunication channels and networks, the recording devices (VCR) established for the mono (nonstereo) TV programs broadcasting and distribution don't need any change - they are absolutely suitable to support the stereo NTSC-DSC TV programs too.

The only new equipments necessary to support the NTSC-DSC stereo TV programing and transmission additionaly to NTSC TV programming and transmission are the stereo binocular NTSC_DSC TV camera forming by two NTSC TV cameras having stereo base shift along the line scanning direction, and the special digital video processor-multiplexer providing the video data compression of the "left" TV signal and time-division multiplexing of the compressed digital images files into the analog NTSC "right" TV signal.

Let's also underline that the transition from NTSC TV sets to NTSC-DSC TV sets will by essentially **simpler and chipper** for customers than the transition from black-and-white TV sets to the color NTSC TV sets. Really, the NTSC TV sets may be directly converted to the NTSC-DSC TV sets simply by adding to NTSC TV set **only** the special **digital video processor** providing demultiplexing the NTSC-DSC TV signal, decompression of the compressed digital images files, generation finally both original NTSC analog "left" and "right" stereo TV signals, and controlling the separate visualization of the "left" and "right" TV signals for the left and right eye viewing accordingly.

## 4. FINAL REMARKS AND CONCLUSION

We sometimes do not fully recognize how important the stereo 3D visualization of the 3D visual reality instead of its 2D truncated imitation might be. Adding third dimension for TV visualization, the NTSC-DSC stereo TV not only essentially enrichs the TV entertainment programs with scenes of natural 3D visual reality like sport programs, landscape scenes, sculpture and architecthural pieces of art, it gives to the creatures of TV programs the new creative 3D tools for visual impression.

Let's imagine also the impression of the video, computer games in the real 3D stereo visualization environment, 3D animated cartoons.

The NTSC-DSC stereo TV potentially may be essentially important in TV education and professional training, for visual simulators.

The transition from color NTSC TV to the color stereo NTSC-DSC TV will give TV viewers not some sort of virtual reality but our 3D visual reality indeed, will be the next important step to transform TV as we know and view it to real Tele Vision when TV viewrs will be able to see from the screen of NTSC-DSC TV set in the same manner as we can see, perceive, and visually-mentally recognize the TV transmitted visual scene without TV directly by their stereo two eyes viewing and vision.

## 5. REFERENCES

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WHITE PAPER

**Video Publication Service - A New Interactive TV public service**

*[TV(video) Publishing House, TV Public Library, Personal TV (video) Book]*

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**Introduction**

It's well known how important the role of the different paper printed information (the paper publication products, service) in all kinds of human and society activities. These paper publication products are directly associated with the paper printing technology introduced still in XV century by Johann Gutenberg (1400-1486). The paper printing technology dominates publishing products market until the second half of this century when paper publication information starts to be disseminated also via telecommunication channels and networks by according electronic signals and digital files.

The fax technology first converts paper publication products to according electronic signals and utilizes public telephone lines as a way for electronic global wide dissemination, distribution of the paper publication products. Unfortunately, this fax technology is a noninteractive and expensive way of the on-line service for delivery of the noncolor, nonperfect image quality paper publication products to remote clients, end-users. The next important steps were on-line interactive service from a remote data (image data, particularly) base (like America Online, for example) or from a myriad of data bases connected via telecommunication network (like hypertext Web pages on Internet) to the distant computer equipped end-users. In spite to the fact that these interactive computer assisted types of the electronic preparation, dissemination, distribution of the paper publishing products much more efficient than the fax technology, they, unfortunately, also have some weaknesses. The most important among them - these interactive computer assisted technologies are still too expensive and do not support the high image quality of the paper printed technology.

The Video Publication Service (**VPS**) is a really new, not only publication, but also public TV service generated by a radically **new, completely interactive and absolutely friendly to customers, TV-watchers** TV technology and system carrying and delivering in a new electronic video, TV form **all** known sorts of publishing (printed) information (products).

Additionally to the interactivity of the **VPS** which is extremely convenient for TV watchers making easier to them **to read** the **text** information and to **look at** the **still** images of the TV publishing product on the screen of TV monitor the **VPS** is the most cost effective electronic media of the mass dissemination, distribution of the publishing information, publishing products for the absolute majority of population if to count the world wide penetration of TV network and practically unrestricted spread of TV sets among the globe population.

Even more than this - the **VPS** is able to generate a completely new publishing product which is impossible to generate by paper printing technology at all and too expensive to generate by on-line computer assisted service - it is the combination, consolidation, fusion of the text, still images, motion pictures, and sound information in the most efficient, convenient, interactive, customer-friendly, and cost effective form for TV watchers.

Let's emphasize also that the **VPS** is completely **compatible** with all existing TV standards because it generates the **VPS's** TV signal in the form of the standard TV format.

Finally, let's remark also that the **VPS** generates a new, the most cost and functionally effective way not only to produce and broadcast the TV advertizing commercials, but really to use them by TV watchers-customers. This remarkable feature of the **VPS** potentially enables to change dramatically TV commercial broadcasting as we it know today breaking up, as a matter of fact, the necessity itself to consolidate TV commercials with TV news, sport, and entertainment program in one fused TV program. As it will be explained later on, such separation, in TV channels and time, "divorce" between commercials and TV news&sport&entertainment programs benefits both branches of TV services, TV watchers - the customers of these two separable branches of TV services.

## The general principles of the VPS technology and systems.

It will be much easier to explain and understand the general principles of the innovative **VPS** technology and systems if to start from the emphasizing of the inefficiency of the standard TV technology and systems for the transmission and reading the **text** information and visual analysis of the **still** images from the screen of TV set. Such inefficiency of the standard TV technology and systems is grounded in the main principle of TV supporting the transmission of the **motion** pictures, **temporal** changes in TV pictures. By the main principle TV is able to transmit every next TV frame as a completely new frame-picture having nothing common with previous frame-picture - the same as for the motion pictures films. The constant frame frequency (field frequency for interlaced TV scanning) 60 frame-pictures per second (50 Hz in Europe) permits to see on TV screen unbroken and unflashed in time motion of the picture's objects. It means that one TV frame has only 1/60 sec. duration which is absolutely inappropriate, insufficient to read the text in TV frame or to analyze an image of this TV frame. So, in order to be readable the same text page needs to be visualized by TV screen by many neighboring TV frames - approximately no less than 7200 TV frames (7200/60 sec.=2 min.) because in average it takes someone around 2 minutes to read text page (the same period of time, approximately 2 minute, well trained radiologist spends to "read", interpret the X-ray of a chest, for example).

It all means that the standard TV technology is very inefficient, redundant for the TV transmission of the text and/or still images information - the standard TV signal utilizes no more than 1/7200 part (!) of the channel capacity being allocated and spent for the transmission of the TV signal when it delivers the text or/and still images information.

More than this, the approximate evaluation of the time needed to read a text page or to visually analyze a still image mentioned above does not count that the really needed time to read and understand the text, to look and interpret an image is **variable** value and fluctuates dramatically because it depends on the essence and complexity of the text and/or image and the analytical skills of the reader-analyst personally. The principle of the direct (on-line) TV broadcasting does not allow to adjust the time of the delivery of the text and/or still image information transmitted and visualized by the standard TV signal with the needed personally different time to read, understand, and interpret this information - the existing standard TV broadcasting by the principle is just not **interactive** at all.

Nothing new to use VCR in order to record on-line broadcasting TV signal and after, off-line to look, read according TV frames-pictures **frame by frame** with managed by the TV reader-analyst the time of the visualization of the "frozen" TV frame so long as it's needed for this TV reader-analyst to read and interpret any TV frame with text and image information in it. It's exactly one of the interactive mode to use VCR - another one, the most general and common mode is to look the recorded TV program with some designed delay after the direct on-line TV broadcasting and without any frame-time scaling-transformation.

But, unfortunately, only the transition to the interactive off-line frame by frame watching of TV signals previously on-line recorded on VCR is not enough to make the TV transmission of the text and/or still images information by according TV signals efficient enough. The only way to make it is to innovate the way of the generation of the TV signal carrying the text and/or still images information in it.

Let's synthesize, therefore, the special TV signal carrying the publishing product (text pages and/or still images) information in the format of the TV standard (NTSC, PAL, SECAM) signal in which each text page needs to be read from the TV screen is represented by only **one** according TV frame, each still image needs to be visually analyzed from the TV screen is represented by only **one** according TV frame. It means, in other words, that there is not any two different TV frames carrying the same text or still image. Therefore, the sequence of the text pages according to the paper printed book (the paper printed publishing product), the sequence of the text pages will be represented in such special **VPS** TV signal by the according sequence of the standard TV frames-pages - every one frame for only one text (or/and still image) page. As it was mentioned before it's possible to incorporate to such **VPS** TV signal carrying publishing (text and/or still image) information the standard video TV signals (video-clips) carrying motion pictures accompanied with according sound. Such fusion of the standard video TV signal (TV clips) and publishing TV signal assembles the **VPS** TV signal ready to be transmitted as the standard video TV signal via standard TV broadcasting, cable, satellite telecommunication channels and networks.

The synthesizer of such **VPS** TV signal by according hard and soft ware may be considered as a virtual **VPS** TV camera.

So, such specially synthesized by a virtual **VPS** TV camera the **VPS** TV signal carrying publishing information is transmitted via standard air (broadcasting), cable, satellite telecommunication channels and networks, then recorded by customer's VCR or other available TV signals recording memory device, and finally visualized on the screen of TV set by the **interactive**, completely controlled by TV reader-analyst regime of the **frame by frame**, page by page reading this publishing information from VCR.

Let's now underline such main features of this new **VPS** technology and system which demarcate them from **all known** TV systems and technologies. The virtual **VPS** TV camera transforms the publishing information into the special publishing **VPS** TV signal in the **standard** TV form (like **NTSC**, **PAL**, **SECAM** standard formats) for which **every next TV frame is a new one** having no **imaging correlation** at all with any previous TV frame(s). It means that such publishing **VPS** TV signal has not any **temporal, interframe redundancy** at all. As it's well known, for **all other** TV signals which are generated by the standard TV cameras and designated for their **direct watching** on TV set their temporal redundancy is very high as far as for the majority of TV frames the correlation between neighboring, consecutive TV frames is very strong with small amount of changes between these frames; correlation is eliminated only for such TV frames which are associated with the radical changes of scene.

The absence of any temporal redundancy in a new special publishing **VPS** TV signals, in other words, the highest possible level of a **complete** elimination of the **interframe redundancy** for these **VPS** TV signals means some virtual interframe video data compression and, therefore, determines the highest level of the efficiency of the transmission the publishing information by these **VPS** TV signals via the standard TV telecommunication channels and networks, and the highest efficiency of the recording of such **VPS** TV signals on VCR. Such efficiency may be estimated by the speed of the transmission of the publishing information, by the price for the delivery every piece (in our case it is the text page) of that information, by the number of the pages of the recorded publishing information available for one **VC** (Video Cassette).

Let's give the quantitative figures for all these three parameters. The different formats for TV frame and paper printed page is the reason why one paper printed page will be represented by **two** TV frames. It means that the speed of the transmission the publishing information is $\mathbf{v}_{tp}$ = **15** pages/second, or **900** pages/minute, or **54,000** pages/hour !

As it's well known, the **VC** in the SP mode providing the highest resolution of the recorded TV signals is capable to record two hours of TV time. It means that one **VC** has on its tape

$$\mathbf{N_{vp} = 108,000\ pages}\ !$$

The price of the delivery for one TV page may be calculated on the base of the price for the delivery of the one TV frame. For the case of the cable channel subscriber the price for one TV frame will be $\mathbf{c_{vp}} = \mathbf{4.5 \cdot 10^{-4}}$ cents/TV frame or **0.0009** cents/TV page **!** Such price even more than **10 times cheaper** than the price of one sheet of clean paper **without any information on it!**

Let's mark and remind that these figures for $\mathbf{v_{vp}}$, $\mathbf{N_{vp}}$, $\mathbf{c_{vp}}$ are received in assumption that the **VPS** technology is based exclusively on the **existing analog** TV technology not using digital image data compression methods and techniques for the reduction of the essential **intraframe spatial** redundancy which is very characterized for a **still** image of the publishing products like text page. In the case of using the digital image data compression technology, for example, like the **JPEG** Standard, the data compression ratio for the images of the video publication may be evaluated in the range no less than **20:1**. It means that by the transition to digital TV technology and image data compression technique, particularly, these figures will be additionally **20** times more profitable for the **VPS**. Such using of the image data compression technique for the reduction intraframe positional redundancy of the publication TV signals means in reality much more than only quantitative gain (benefit), it will give some very important qualitative change of the **VPS** technology like more simple and cheaper VCR and the possibility to spread widely the **VPS** using it for more and more kinds of publication products.

The second feature of the "publishing" TV frame (text and/or still image) is that it does not accompanied by any **sound** information. It means that the sound channel of the TV transmission line may be used in the case of the **VPS** as the channel for the **bi-directional** communication between cable channel subscriber and cable channel operator for the transmission the **demands** from subscriber(s) and control signals from cable channel operator (computer) to manage the regime of the recording by subscriber's **VCR**. An empty sound channel for the **VPS** TV may be used also for some digital signals for TV publishing frames controlling their recording and reading by VCR.

The next feature of the publishing TV signals is that they can not be watched on the screen of TV set **directly** because every next TV frame is **new** one and visual-mental capability of the human observer to read, to understand, and recognize the essence of the text information on the screen is much-much more than duration of one TV frame (**1/30** sec.). Really, we need no less than about **2** minutes (**120** seconds) only for simple reading of one text page. Therefore, the virtual video data compression ratio providing by **VPS** TV technology may be evaluated as no less than **120x15 = 1,800** times**!**

Let's underline once more time that the **VPS** is capable to provide **all sorts** of information which is available by the standard existing paper publishing technology which reproduces on the paper page the combination of the text and still pictures. These publications are: periodical and nonperiodical publishings, news papers, news letters, magazines and journals, catalogs, directories, patents and Trade Marks, official records, books, text books, manuals and Training Courses - to name a few. More than this, a new **VPS** have the possibility to deliver a radically new publishing products - the consolidation of the text, still and **motion** pictures accompanied by sound as well.

Now let's emphasize the difference between interactive of-line **VPS** and other interactive computer assisted electronic on-line services for dissemination and delivery of the publishing (paper printed) information. First of all, computer assisted on-line service allocates the channel capacity of the telecommunication channel exclusively for only **one** end-user, when the **VPS** under its TV broadcasting principle have not **any** restriction on the number of end-users using allocated channel capacity of the TV broadcasting. Number two, computer assisted on-line service visualizes the publishing products with the restricted number of fonts for alpha-numerical representation of the text.

## The conclusion and final remarks

Let's start from the remark that the **VPS** supports two categories of the publishing products. The first one is some electronic video analogue (duplication) of the existing paper publishing products. The second group is rather principally **new** publishing products for which we cannot find analogue among previously published paper printed publishing products.

Let's remind, particularly, that the libraries and archives have accumulated all sorts of paper printed publishing products before introduction a new **VPS** and therefore there is the necessity to generate from paper printed publishing products their video duplicates. At the same time for all new publishing products video duplicates may be and needs to be generated directly as the transformation of the electronic digital publication files to the corresponding publishing **VPS** TV signals.

Let's emphasize one more time that the **VPS** closes the very essential and wide gap which exists right now in dissemination and delivering via telecommunication channels and networks the publishing information and products to such majority of global population which have not personal computers and access to on-line services and/or Internet at all.

Let's mention also that beyond a direct influence on the publishing products market the **VPS** will have some indirect but very important impact on the TV equipment market. It's no doubts that the **VPS** will boost many TV products which already on the market widely. Really, until TV systems were targeted only for the TV direct **watching**, TV sets, VCR were some family goods for not only personal but collective watching as well. Reading from the paper or from the screen of TV set is definitely **individual**, **personal** process. Therefore, the introduction of the **VPS** will give essential boost for the production and selling additional VCR's and TV sets like previous situation in auto car business demonstrates when additionally to family car many families bought personal cars as well. The introduction of the **VPS** will also initiate the design, production, and selling some special new combinations of standard TV products like, for example lap-top TV sets with VC(CD) player (or VCR) - TV library-books.

It is important to mention that the implementation of **VPS** will save a lot of publicly available bandwidth for air, wireless transmission because the broadcasting of the **VPS** TV programs may be implemented at night time on the same TV channels when regular TV broadcasting for direct watching is esentially restricted on them.

It is necessary especially underline finally that the creation of the **VPS** will have extremely new and important impact not only on the market but it will have, hopefully, very essential influence on the social-political life of the society as well. The introduction and nationwide and worldwide implementation of the **VPS** and its products is capable potentially to enrich community and personal intellectual life, to change the share of TV sets watching time in some desirable social direction, to increase the **active** and **social productive** portion of this time for TV **reading**, **studying**, **training** and accordingly to decrease the passive TV contemplation which sometimes leads to some sort of dullness. More than this, the **VPS** potentially can transform drastically the advertising business on TV.

Let's say that concept of the **VPS** will change the way of the improvement for libraries and archives as far as the **VPS** is the **cheapest** and the most **democratic** way to accumulate, disseminate and deliver the knowledge and arts in the most expressive visual forms available for the majority of the global population. Finally, it's necessary to underline that the **VPS** technology is environment clean, recycled technology capable widely to safe a lot of the natural resources.